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REVIEWS

Geological Expedition to Brazil and Chile, 1908-1909. By J. WOODWORTH. Bull. Mus. of Comparative Zoölogy, Harvard College, Vol. LVI. Shaler Memorial Series, No. 1. Pp. 137, figs. 37, pls. 37. Cambridge, Mass., 1912.

In commemoration of the long and distinguished services rendered to Harvard University by the late Dean Shaler, the alumni of that institution raised an endowment of more than thirty thousand dollars for the purpose of conducting appropriate investigations and publishing the results as a tribute to his memory. As the evidence of past glaciation was one of the lines of study which particularly commanded Professor Shaler's interest, and as he long ago anticipated the discovery of evidences of glaciers in the conglomeratic formations of the closing Paleozoic era, it seemed eminently fitting that a portion of the memorial fund be expended for further research on the Permian conglomerates of southern Brazil, the glacial origin of which was suggested by Dr. Orville A. Derby in 1888. This report is the result of an expedition organized for that purpose.

Following the itinerary and narrative of the expedition, there is given a brief outline of the geology of south Brazil based chiefly upon the publications of Derby and of Branner and the special report on the coal area by I. C. White. The formations which enter into the structure of southern Brazil may be grouped into the following terranes: (1) The belt of igneous and metamorphic rocks of the coast, including the Serra do Mar region, frequently classed as Pre-Cambrian and certainly Pre-Devonian. (2) The Devonian, including the sandstone cuesta of the Serra das Furnas and the overlying fossiliferous shales of Ponta Grossa in the state of Paraná. (3) The Permian series, including conglomerates and tillite beds as well as sandstones and shales, the latter coal-bearing in the south. (4) The Triassic sandstones and trap sheets, the latter making the escarpment known as the Serra Geral and its topographical equivalents elsewhere. (5) The Tertiary fresh-water deposits of the upland, and possibly along the coast. (6) The Recent deposits along the coastal borders, now slightly elevated.

The declared purpose of the expedition having been the investiga-

tion of the Permian glacial formations of southern Brazil, most attention was devoted to these interesting and significant deposits. Thick deposits of tillite were found quite extensively in the state of Paraná and in the adjacent portions of São Paulo and Santa Catharina. No glacial rock floor, however, has yet been found in south Brazil, nor have the larger boulders been found to bear striated surfaces, but the members of the expedition found ice-worn surfaces on pebbles and on fragments of rock ranging up to the size of a man's head. Distinctly striated pebbles had not been discovered previously in these deposits. While maintaining a position of reserve, Woodworth believes that the gorge of the Iguassu at the point where the railway crosses it at Serrinha Station affords evidence of two glacial epochs within the Permian.

The author refers to the hypothetical Gondwana-land and inquires whether it included Paraná-land. In particular he raises the question whether there was a land connection between South America and Africa in Permo-Carboniferous times. He follows Suess in thinking that the Atlantic Ocean basin may have had its origin in post-Triassic times! He says: "Certainly the assumption of an Atlantic trough in pre-Triassic times having anything like the present extent of the basin must be abandoned as being without sufficient geological evidence." He ends by saying: "We may conclude therefore that the geologist is free to converge the coasts of Africa and South America in Permian and earlier Carboniferous time as closely as any biological facts and geological evidences of land may demand for their explanation."

No doubt the great name Suess may warrant the taking of such convenient liberties with masses of continental dimensions, but to one who has toiled for a year or so on the ancient crustal wrinkles that face the South Atlantic it sounds like an excerpt from the Romance of Cataclysm.

As a possible aid to genetic hypotheses of low latitude glaciation the author cites at length from authorities to show the frequency and effectiveness of hailstorms in warm countries and elsewhere, and seems to lean toward an explanation of Permian glaciation along this line. He would perhaps have added to the value of his contribution if he had drawn a sharper line between hot-weather hailstorms that spring from violent columnar convection and which drop their ice product in the hot bed that gave them origin, on the one hand, and, on the other, the common case of frozen rain and sleet that form when the conditions are on the wavering line between freezing and not freezing. The former have the merit of giving an impressive demonstration of the nearness

of a glacial zone above us, while the latter are but details of the border ground of common ice precipitation.

The author confesses to uncertainty regarding the cause of the Permian and Pleistocene glaciations, but he takes only three sentences to do up "the recently elaborated hypothesis that glaciation may be brought about through the temporary reduction of the amount of carbon in the earth's atmosphere." He says this theory "leaves unexplained the shortly succeeding ice advances between whose dates no corresponding appreciable reduction in the carbon is registered by rock-making in the earth's crust." Something no doubt is to be allowed for infelicity in phrasing when one is giving so short a shrift to a theory, but the author seems to lack a close acquaintance with the view he rejects. There are different views in which carbon dioxide plays a part, but there is only one that has been "elaborated" in a geological sense. This view makes a radical distinction between a glacial period and its oscillations, as also between fundamental agencies that may bring on a glacial period and auxiliary agencies that can only impose oscillations on it. The glacial period in this view persists through the whole series of oscillations, and the fundamental agencies continue in effect and action throughout. The fundamental agency assigned by this hypothesis is world-wide diastrophism which acts on the atmosphere by the increased contact it gives, and leads to its depletion; it also acts physically and mechanically. The chief auxiliary agency assigned to the production of oscillations is the ocean which holds 90 per cent or more of all the free and semi-free carbon dioxide on the face of the globe. The ocean alternately absorbs and gives forth carbon dioxide as set forth in detail by the author of this view. It is misleading to say that this hypothesis "leaves unexplained" the glacial oscillations, for it not only offers an elaborate explanation but is without a rival in the explicitness with which it draws forth and lays emphasis on the character of these oscillations, particularly that singular combination of subequal ice advances with continually shortening time-intervals between them. The author was of course altogether at liberty to say that in his judgment the explanation is inadequate or incompetent, but readers will hardly commend his precision of statement when he tells them that it leaves unexplained the oscillations when in fact it offers the most explicit explanation yet put in print, except perhaps that of Croll on quite a different line.

In summarizing the geomorphology of south Brazil the author brings out clearly the two distinct topographic units, the tableland, or

planalto, and its steep coastal border which constitutes the Serra do Mar. The region was baseleveled in the late Mesozoic, and the summits of the Serra do Mar which rise above the plateau level were probably more resistant granitic bosses which had not been reduced to the base plain. Uplifts in Tertiary and subsequent times have contributed to the present elevation and to the existing status of erosion.

The bulletin closes with a note on the changes of level on the coast of southern Chile. Starting out with the intention of studying the nature of the Pleistocene and Recent uplifting of the Chilean coast, first described by Charles Darwin, Woodworth failed to find good evidence of any extensive rise of the coast in Quaternary times. A late Pliocene or early Pleistocene uplift of about sixty feet at Valdivia, a late Pleistocene uplift of forty-five feet at Concepción, and a recent rise of lesser magnitude were indicated by these studies.

R. T. C.

“Formation of Coal Beds.” II. By JOHN J. STEVENSON. *Proc. Am. Phil. Soc.*, Vol. L, No. 202, 1911.

The author of this article has prepared a careful survey of the literature bearing on the origin of coal beds. He has presented much data regarding the origin and character of transported organic matter and discussed the significance of floods and torrents as eroding and transporting agencies. There are three major divisions of the subject:

1. Rainfall barely disturbs the cover of litter in a forest and the latter is practically uninjured by the heaviest rainfall. Rainfall does not remove soil covered by vegetation unless this mantle is ruptured. Torrents produce but slight effects upon the rocks or vegetation over which they flow unless they carry considerable débris; trees of small and large diameter resist mountain torrents that are even loaded with coarse débris. Where the torrents come from regions having a good mantle of vegetable matter they are practically free from inorganic load.

2. Descriptions of peat deposits are included under this head and data from widely scattered regions are brought together showing the geographic and stratigraphic position of the beds, the botanical constitution, the appearance, thickness, and degree of consolidation. Peat consists of more or less altered plant material whose organic texture is recognizable and of an inclosing substance evidently derived from complete decomposition of the plant tissues. This is all more or less mixed with sedimentary sand, clay, or calcareous matter. Peat always contains a large amount of water. The fact is pointed out that peat does accumulate in the tropics